

Natural Gas Passenger Vehicles: Availability, Cost, and Performance

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Summary

Higher gasoline prices in recent years and concerns over U.S. oil dependence have raised interest in natural gas vehicles (NGVs). Use of NGVs for personal transportation has focused on compressed natural gas (CNG) as an alternative to gasoline. Consumer interest has grown, both for new NGVs as well as for conversions of existing personal vehicles to run on CNG. This report finds that the market for natural gas passenger vehicles will likely remain limited unless the price for natural gas remains substantially lower than gasoline to offset the higher purchase price for an NGV.

The Environmental Protection Agency (EPA) promulgated new regulations in April 2011 on alternative fuel vehicle conversions—including natural gas conversions. The new regulations allow greater flexibility for conversion companies to certify that their conversions do not lead to higher emissions—flexibility that could lead to significantly lower compliance costs. This could help spur the proliferation of natural gas conversions, especially for older vehicles.

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Introduction

Congressional and consumer interest in passenger natural gas vehicles (NGVs) has grown in recent years, especially in response to higher gasoline prices, concerns over the environmental impact of petroleum consumption for transportation, and policy proposals such as the “Pickens Plan.”¹ Although natural gas passenger vehicles have been available for years, they have been used mostly in government and private fleets; very few have been purchased and used by consumers. Larger NGVs—mainly transit buses and delivery trucks—also play a role in the transportation sector, especially due to various federal, state, and local incentives for their use. However, high up-front costs for new NGVs, as well as concerns over vehicle performance and limited fuel infrastructure, have led to only marginal penetration of these vehicles into the personal transportation market.

Current Market

The Energy Information Administration (EIA) estimated that there were roughly 114,000 compressed natural gas (CNG) vehicles in the United States in 2009, and roughly 3,000 liquefied natural gas (LNG) vehicles.² Roughly two-thirds of NGVs are light-duty (i.e., passenger) vehicles. This compares to roughly 235 million conventional (mostly gasoline) light-duty vehicles.³ Further, of the roughly 11.6 million new light-duty vehicles sold in 2009, only about 400 (0.004%) were NGVs.⁴ For model year (MY) 2012, only two passenger NGVs are available from original equipment manufacturers (OEMs) for purchase by consumers—the CNG-fueled Honda Civic GX⁵ and the Vehicle Production Group MV-1⁶—although some companies convert vehicles to CNG before they are sold (usually as fleet vehicles).

Life-Cycle Cost Issues

While the current purchase prices for NGVs exceed those of conventional vehicles, much of this difference can be made up over the life of the vehicle in fuel cost savings. For example, the incremental price between a conventional Honda Civic EX and a natural gas-powered Honda Civic GX is over \$5,000.⁷ Through 2010 some of this difference was made up through a tax credit for the purchase of new alternative fuel vehicles, but that tax credit has since expired.⁸ It should

¹ On July 8, 2008, T. Boone Pickens announced a plan calling for reduced petroleum imports through the expanded use of natural gas in transportation. For an analysis of this plan, see CRS General Distribution Memorandum, *The T. Boone Pickens Energy Plan: A Preliminary Analysis of Implementation Issues*, by Jeffrey Logan, William F. Hederman, and Brent D. Yacobucci.

² U.S. Energy Information Administration (EIA), *Alternatives to Traditional Transportation Fuels 2009*, April 2011. Tables V1 and V4.

³ Stacy C. Davis, Susan W. Diegel, and Robert G. Boundy, *Transportation Energy Data Book: Edition 30*, 2011. Tables 4.1 and 4.2.

⁴ Davis et al. op. cit., Tables 4.5 and 4.6; EIA, op. cit., Table S2.

⁵ For MY2004, there were eight CNG models (from Ford, General Motors, and Honda). This number dropped to five in MY2005 and one in MY2006. U.S. Department of Energy (DOE), *Fueleconomy.gov* (<http://www.fueleconomy.gov/>).

⁶ A wheelchair-accessible mobility vehicle.

⁷ 2011 Honda Civic EX (automatic transmission) MSRP: \$20,505. 2011 Honda Civic GX MSRP: \$26,155. \$26,155 - \$20,505 = \$5,650.

⁸ Energy Policy Act (EPAct) of 2005. P.L. 109-58, Sec. 1341. If a taxpayer qualified, he or she could claim a credit of up to \$4,000 for the purchase of a new natural gas passenger car. Tax credits were higher for heavier vehicles (e.g.,

be noted that with higher production, this incremental cost should decrease, but the likely extent of that decrease is unclear.

Since the number of natural gas refueling stations is limited—only about 400 publicly available nationwide,⁹ compared to roughly 120,000 retail gasoline stations¹⁰—the purchaser of a new NGV might also choose to install a home refueling system. According to *Consumer Reports* and Natural Gas Vehicles for America (NGVAmerica), a FuelMaker Phill system costs between \$3,400 and \$4,500 plus installation.¹¹ However, through the end of 2011 a taxpayer could offset \$1,000 of this by claiming a tax credit for installing new alternative fuel refueling infrastructure.¹²

Offsetting the higher up-front costs are likely annual fuel savings in switching from gasoline to natural gas. Using average retail gasoline and residential natural gas prices from January 2011, annual fuel cost savings could be roughly \$600.¹³ Assuming a 3% discount rate, the payback period for the CNG vehicle and home refueling system is more than 17 years. Given that this is roughly the median survival age for new passenger vehicles, this payback period may or may not be acceptable to that consumer.

Assuming a smaller differential between natural gas and gasoline prices, or other factors (e.g., the expiration of tax incentives), can significantly increase this payback period; assuming a larger difference in fuel prices (as was the case in spring 2011), assuming a smaller discount rate, or assuming incremental natural gas vehicle prices decrease in the future, this payback period could be shorter.

Other Potential Benefits and Costs

In addition to the life-cycle cost difference between CNG and conventional vehicles, there are other costs and benefits associated with NGVs that may not have a defined market price tag. For example, any reduction in petroleum dependence (beyond the per-gallon cost savings) is not represented in the above payback period estimate. Some consumers may place a value on displacing petroleum consumption, and thus imports.¹⁴ Further, NGVs in general have lower

buses or delivery trucks).

⁹ Roughly half of the approximately 900 natural gas refueling stations are privately owned or are located at government sites closed to the public (e.g., military bases). Of the public CNG refueling stations, many require a keycard or other prior arrangement with the station operator.

¹⁰ DOE, Alternative Fuels and Advanced Vehicles Data Center (AFDC), *Alternative Fueling Station Locator*. http://www.eere.energy.gov/afdc/fuels/stations_locator.html.

¹¹ “The natural-gas alternative: The pros & cons of buying a CNG-powered Honda Civic,” *Consumer Reports*, April 2008. Stephe Yborra, NGVAmerica, *Frequently Asked Questions About Converting Vehicles to Operate on Natural Gas*, Washington, DC. http://www.ngvc.org/pdfs/FAQs_Converting_to_NGVs.pdf. One potential impediment to this is the fact that in April 2009, FuelMaker declared bankruptcy in Canadian court. In May 2009, Fuel Systems Solutions, Inc., purchased some of FuelMaker’s assets, including the Phill brand. Reuters, “Key Developments: Fuel Systems Solutions Inc (FSYS.O),” May 28, 2009, <http://www.reuters.com/finance/stocks/keyDevelopments?symbol=FSYS.O&pn=1>.

¹² EAct 2005. P.L. 109-58, Sec. 1342. This credit was extended through the end of 2011 by the Tax Relief, Unemployment Insurance Reauthorization, and Job Creation Act of 2010 (P.L. 111-312, Sec. 711).

¹³ Savings of \$628 per year based on the following assumptions: 15,000 annual miles traveled (both vehicles); 29 miles per gallon (mpg) fuel economy for gasoline vehicle; 28 mpg equivalent for natural gas vehicle; \$3.38 national retail average for regular gasoline; compressed natural gas price of \$2.09 per equivalent gallon. Fuel economy and fuel price estimates from DOE, Fueleconomy.gov (<http://www.fueleconomy.gov/>).

¹⁴ However, it should be noted that a reduction in domestic consumption will likely not lead to a one-to-one reduction in imports, since reducing domestic consumption is also likely to reduce domestic petroleum production.

pollutant and greenhouse gas emissions than comparable gasoline vehicles, although this may or may not be true for specific vehicles and pollutants.¹⁵

A key potential benefit raised by proponents of NGVs is that while the United States imports the majority of the petroleum it uses, most natural gas is domestically produced. Further, domestic output is higher than once thought, mainly due to recent growth in unconventional natural gas sources (e.g., coal mine methane, shale gas).¹⁶

But there are also several potential and measurable drawbacks to NGVs, many related to vehicle performance and acceptability. For example, CNG engines tend to generate less power for the same size engine than gasoline engines. Thus NGVs tend to have slower acceleration and less power climbing hills.¹⁷ Also, because CNG has a lower energy density than gasoline, CNG vehicles tend to have a shorter range than comparable gasoline vehicles.¹⁸ In addition, for passenger vehicles, the larger natural gas storage tanks often occupy space that would otherwise be used for cargo—generally in the trunk of a sedan and in the bed of a pickup truck.¹⁹ Again, these considerations may or may not play into a individual purchaser's decision, but could affect the overall marketability of the vehicles.

NGV Conversions

A key question raised by those interested in the expansion of natural gas for automobiles is whether existing vehicles can be converted to operate on natural gas. From a technical feasibility standpoint, there are few problems with converting a vehicle to operate on natural gas. Most existing engines can operate on the fuel, and most conversions involve changes to the fuel system, including a new fuel tank, new fuel lines, and modifications to the vehicle's electronic control unit.²⁰

Until recently, when EPA reduced restrictions, converting an existing vehicle was more problematic from a practical standpoint. In the United States, NGV conversions—or any other fuel conversion—can potentially run afoul of the Clean Air Act (CAA). All new vehicles (gasoline or otherwise) must pass rigorous tests to prove they will meet emissions standards over the life of the vehicle. These tests tend to be very expensive, although the marginal cost spread over a full product run—thousands to hundreds of thousands of vehicles—is minimal. After a vehicle has been certified by the Environmental Protection Agency (EPA), any changes to the exhaust, engine, or fuel systems may be considered tampering under the CAA. Section 203(a)(3)(A)²¹ states that it is prohibited

¹⁵ DOE, AFDC, *Natural Gas Benefits*. http://www.eere.energy.gov/afdc/fuels/natural_gas_benefits.html.

¹⁶ It should be noted that high natural gas prices may be needed to sustain some of this output. Otherwise, the United States may need to import natural gas to meet growing demand. See CRS Report R40894, *Unconventional Gas Shales: Development, Technology, and Policy Issues*, coordinated by Anthony Andrews.

¹⁷ The 2011 CNG Honda Civic is rated at 113 horsepower (hp), while the gasoline Civic EX is rated at 140 hp (both have 1.8 liter engines). Honda Motor USA website, <http://automobiles.honda.com>.

¹⁸ 170 miles for the Civic GX vs. 345 miles for the gasoline Civic. DOE, *Fueleconomy.gov* (<http://www.fueleconomy.gov/>).

¹⁹ All current NGVs are modified versions of conventional gasoline vehicles. Presumably, if there were enough consumer demand, a natural gas vehicle designed from the ground up could address the problem of cargo capacity.

²⁰ NGV Conversion, Inc., *Frequently Asked Questions*. <http://ngvus.com/p/index.html>.

²¹ 42 U.S.C. 7522(a)(3)(A).

for any person to remove or render inoperative any device or element of design installed on or in a motor vehicle or motor vehicle engine in compliance with regulations under this title prior to its sale and delivery to the ultimate purchaser, or for any person knowingly to remove or render inoperative any such device or element of design after such sale and delivery to the ultimate purchaser.

EPA generally interprets this to mean that any change to a vehicle's engine or fuel systems that leads to higher pollutant emissions constitutes "tampering" under Section 203.

EPA Guidance Prior to 2011

In 1974, EPA issued guidance ("Memorandum 1A") to automaker and auto parts suppliers on what constituted tampering in terms of replacement parts under routine maintenance.²² The guiding principle EPA has used in enforcing the anti-tampering provisions for alternative fuel conversions is that such changes are allowed as long as the dealer has "reasonable basis" to believe that emissions from the vehicle will not increase after the conversion. Instead of requiring all converted vehicles to undergo testing equivalent to new vehicle testing, EPA allowed vehicle converters flexibility in certifying their emissions.

However, in the 1990s, EPA received data from the National Renewable Energy Lab that many vehicles converted to run on natural gas or liquefied petroleum gas (LPG) and certified under the flexibility provisions might be exceeding emissions standards.²³ Therefore, in 1997 EPA issued an addendum to Memorandum 1A tightening the testing standards for these conversions. The original decision required compliance with new testing procedures starting in 1999. Subsequent revisions extended the deadline through March 2002.

Under guidance from the 1990s and 2000s, certifying vehicle conversions could be very expensive for small producers, since each vehicle needed to be independently certified. For example, a converter needed to test the emissions of the conversion of specific "engine families" (e.g., MY2008 Ford Vehicles with 4.6L V8 engines). Each different engine/emissions system combination was tested independently (e.g., MY2009 vehicles, or vehicles with different engines). Therefore, the production and use of universal "conversion kits" was effectively prohibited under the EPA enforcement guidance.²⁴ NGV America estimated that it could cost as much as \$200,000 to design, manufacture, and certify a conversion for a single engine family under the then-current guidance.²⁵

New EPA Regulations from April 2011 — Added Flexibility for Converters

On April 8, 2011, EPA issued final regulations on alternative fuel vehicle conversions.²⁶ The regulations provide new flexibility for converters to certify that their conversions do not violate the CAA anti-tampering provisions. Most notably, while most requirements for conversions of

²² EPA, Office of Enforcement and General Counsel, *Mobile Source Enforcement Memorandum 1A*, June 25, 1974.

²³ EPA, Office of Enforcement and Compliance Assistance, *Addendum to Mobile Source Enforcement Memorandum 1A*, September 4, 1997.

²⁴ To make a conversion kit that would work for all vehicles, a manufacturer would need to certify the emissions of the conversion on every engine family for all model years—a very expensive proposition.

²⁵ Stephe Yborra, op. cit.

²⁶ Environmental Protection Agency, "Clean Alternative Fuel Vehicle and Engine Conversions; Final Rule," 76 *Federal Register* 19830-19874, April 8, 2011.

“new and relatively-new”²⁷ remain relatively unchanged—these vehicles must still generally go through all new vehicle testing—EPA has relaxed requirements for “intermediate age”²⁸ vehicles and “outside of useful life” vehicles.

EPA estimates that the total certification costs (emissions testing, administrative costs, etc.) will be reduced for all three classes of vehicles. Cost reductions for intermediate age and outside of useful life vehicles could be dramatic.²⁹ For older vehicles, less detailed testing is required—much of the savings comes from minimal testing of the on-board diagnostic (OBD) system for older vehicles.

Another key flexibility for all groups is that while EPA’s certification expires after one year, EPA has determined that, assuming conditions do not change significantly (e.g., the conversion kit is not modified after the system is certified), EPA’s waiver of the anti-tampering provisions remains in effect. There may be other issues with the expiration of the certification,³⁰ but conversions would not run afoul of the CAA.

Other Issues with Conversions

Some have questioned whether a vehicle conversion would void the original manufacturer’s warranty. However, only those vehicle systems directly modified by the conversion would raise warranty concerns. In those cases, the conversion manufacturer’s warranty would cover the modified systems. For systems not affected by the conversion (e.g., suspension, climate control), the original manufacturer’s warranty would still apply.³¹

Legislation

Several bills have been introduced in recent years to promote NGVs and NGV infrastructure. Most notably in the 112th Congress, the New Alternative Transportation to Give Americans Solutions Act (Nat Gas Act) of 2011 (H.R. 1380 and S. 1863) would provide a wide range of incentives. The Nat Gas Act would reinstate the tax credit for the purchase of NGVs (which expired at the end of 2010), significantly expand the tax credit for the installation of natural gas refueling infrastructure, and extend both credits through 2016. The bill would also provide a tax credit to automakers who produce NGVs, and would authorize grants to those automakers to develop natural gas engines.

Conclusion

Higher gasoline prices and concerns about U.S. oil dependence have raised interest in NGVs. Energy policy proposals such as the Pickens Plan have further raised interest in these vehicles.

²⁷ Vehicles from the current model year or one year older.

²⁸ Vehicles from two model years earlier or older, but still within their useful life. For recent vehicles, EPA defines “useful life” as 10 years or 120,000 miles.

²⁹ For example, in the preamble to the final rule, EPA uses a case of certifying four vehicle groups. Under the old regulations, EPA estimates the total cost would have been roughly \$177,000. Under the new rules, EPA estimates that the total cost drops to \$147,000 for new vehicles and \$53,000 for intermediate age vehicles. EPA did not estimate the costs for outside of useful life vehicles, but stated that compliance costs could be similar to those for intermediate age vehicles.

³⁰ For example, if tax credits or other financial incentives (e.g., state or federal grants) for the purchase of new vehicles are tied to the vehicle having a current EPA certification.

³¹ Stephe Yborra, op. cit.

However, currently the number of new passenger vehicles capable of operating on natural gas is relatively low, and there are limited opportunities for converting existing gasoline vehicles to run on natural gas.

The market for NGVs will likely remain limited unless the differential between natural gas and gasoline prices remains high in order to offset the higher purchase price for a natural gas vehicle or if new incentives are established to decrease the differential in initial vehicle purchase prices. New EPA regulations on NGV conversions could help promote the expansion of NGVs by lowering the cost of entry for conversion companies.

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